# APPENDIX G

# COST ANALYSIS METHODOLOGY: LITHOGRAPHIC BLANKET WASHES CTSA

## BLANKET WASH COST ANALYSIS METHODOLOGY

The methodology described below was used to estimate the cost of using the baseline blanket wash as well as the cost of using 22 substitute blanket washes. The primary source of information for the cost estimates was the performance demonstration conducted during production runs at 17 volunteer facilities in late 1994 and early 1995. This information was supplemented by several other sources, including: (1) industry statistics collected by trade groups; (2) lease prices for cloth printer's wipes from a large east coast industrial laundry; and (3) EPA's risk assessment work.

The performance demonstration collected data on the use of donated, substitute blanket wash products and the baseline, VM&P Naptha. Substitute products were screened for blanket swell and washability; each was then sent to two printing facilities. Each facility also tested the baseline product; results are presented comparing the substitute products to the baseline. Although each facility was to use the substitute product for one week, performance problems and scheduling conflicts resulted in some products being used more than others.

Certain assumptions were used in this analysis to smooth out the differences among the various facilities participating in the performance demonstration in order to make the results comparable and to remain consistent with assumptions used in other parts of this CTSA. For example, it was assumed that there are four blankets or "units" per press, each of which is washed 10 times per shift. Additionally, it was assumed that work is performed for one 8-hour shift per day, 5 days per week, 50 weeks per year. Using these assumptions, the following costs were estimated for individual facilities involved in the performance demonstrations for the baseline blanket wash and each substitute blanket wash:

- Total cost/wash.
- Total cost/press.
- Total cost/press/shift/year.

A general description of the cost estimation methodology and data sources used is below, followed by a more detailed description of the methodology.

### General Description of Costing Methodology

In general, the cost estimate for each reclamation method combines product cost and product performance data. Variations in the sample sizes, the value for 'n', found in the labor rate (time), the number of wipes per cleaning, quantity of wash used and number of cleanings used to determine performance are due to differences in the way the data for each factor was collected. For example, in the case of the time required to clean the blanket, only the data collected by the observer on the first day of the demonstration were used in the assessment. In determining the average quantity of blanket wash used, data collected during the entire week were utilized in the assessment resulting in a higher sample size. The final cost estimates are a combination of the three distinct cost elements listed below:

Labor

The time spent to clean the blanket was recorded in the performance demonstrations by the observer on the first day of the demonstration for each product, as it was not feasible for press operators to time themselves while cleaning. Therefore, estimates of time to clean the blanket recorded by observers were used to calculate the labor cost.[1] The labor cost was calculated as the total time spent multiplied by (1) the average wage rate for lithography press operators of $15.52/hour; (2) an industry fringe rate (to account for holiday and vacation) of 1.07; and (3) an industry multiplier of 1.99 to account for overhead costs. All of these cost elements were calculated from industry statistics reported in NAPL's *1993 Cost Study* and are explained in more detail in the next section.

Blanket wash products

The quantity of blanket wash used per blanket was recorded during the observer's visit and by the press operator during the week of demonstrations. Average usage per blanket was calculated at each facility for both the baseline product and the 22 substitute products. Multiplying usage per wash, accounting for dilution where necessary, by the unit cost of each product (provided by each participating manufacturer and summarized in Table G-1) yielded the blanket wash costs.

Materials (i.e., wipes)

The only materials consumed in manual blanket washing are the wipes used by the press operator to wash the blanket. All but one of the print shops participating in the performance demonstration used cloth wipes; the other used disposable wipes. Materials costs were therefore calculated by multiplying the number of wipes used, as recorded in the performance demonstrations, by the lease price of a cloth printer's wipe. (A representative of Standard

Uniform Services, one of the largest industrial laundries in Massachusetts, provided an estimated lease price of $0.11 per wipe.)

[1] An alternative method of determining the labor time was examined, apart from using the average time estimates compiled by observers. Within each facility, observers and press operators collected data on the number of blanket rotations per wash. Because only observers compiled time estimates, the rotations data included more observations and was, therefore, considered as an alternative method for estimating labor time. However, this approach was abandoned after further analysis found poor correlation between time and number of rotations. Although occasionally high correlation was found to exist, the majority of facilities did not show a high degree of correlation. Eight facilities with the greatest number of observations were analyzed separately to determine if time and number of rotations were correlated. Again, poor correlation was found. This is interpreted to mean that there was not a preset cleaning speed for the rotation of the cylinders; we were not, therefore, able to use the number of rotations multiplied by the average time per rotation recorded by the observer to determine the labor time involved with cleaning the cylinders. In addition, the ink coverage changed from one cleaning to the next, adding a variation which affected the cleaning time. However, poor correlation between time and number of rotations was also found to exist for facilities that reported consistent ink coverage.

The trend in the number of rotations necessary to clean a cylinder was also examined to determine if there was a learning curve involved with using the alternative cleaners. While it is believed that there is a learning curve, the demonstration timetable was too short for this observation, which was further complicated by variable ink coverage.

| TABLE G-1: SUBSTITUTE BLANKET WASHES, MANUFACTURER PRICING | |
|---|---|
| **Blanket Wash Number and Type** | **Product Cost per Gallon ($)** (based on the 55 gallon drum price)($)** |
| Baseline - VM&P Naphtha | 5.88 |
| 1 - Vegetable Fatty Ester | 20.00 |
| 6 - Ester/Petroleum + Surfactant | 12.35 |
| 9 - Ester/Water | 10.26 |
| 10 - Ester/Water | 9.55 |
| 11 - Ester/Petroleum + Surfactant | 12.15 |
| 12 - Petroleum/Water Diluted for Use | 16.40 |
| 14 - Vegetable Fatty Ester + Glycol | 9.55 |
| 19 - Vegetable Fatty Ester + Glycol | 11.80 |
| 20 - Petroleum/Water | 10.80 |
| 21 - Ester/Petroleum | 10.08 |
| 22 - Water/Petroleum/Ester | 13.15 |
| 24 - Terpene | 17.85 |
| 26 - Vegetable Fatty Ester | 12.24 |
| 29 - Vegetable Fatty Ester | 18.00 |
| 30 - Petroleum/Water Diluted for Use | 5.00 |
| 31 - Petroleum | 9.80 |
| 32 - Petroleum | 2.85 |
| 34 - Water/Petroleum/Ester | 15.00 |
| 37 - Petroleum/Water | 14.80 |
| 38 - Ester/Petroleum | 19.00 |
| 39 - Petroleum/Water | 8.95 |
| 40 - Ester/Petroleum + Surfactant | 10.25 |

** Unit costs supplied by manufacturers participating in the performance demonstrations.

Figure G-1 shows a graphical display of the relative cost changes (substitute compared to baseline) at each facility followed by a summary of the cost comparisons in Table G-2.[2] Figure G-1 illustrates the range of percentage cost changes (compared to the baseline) measured at each facility. Two points are plotted for each of the substitute products because each was tested at two facilities. Formulations are arranged by ascending VOC content. Cost comparisons for each blanket wash against the baseline are provided at the end of this section; summary paragraphs are followed by tables providing specific results. Absolute and relative cost variations are reported for each substitute. An increase in the time required to clean the blanket, quantity of wash

[2] Products 9, 22, and 32 are not included within Figure G-1 because VOC content for these products was not available.

solution used, number of wipes expended, and costs of labor and materials is preceded by a plus sign; conversely, decreases are denoted by a minus sign.

**FIGURE G-1: BLANKET WASH COSTS CHANGES ARRANGED BY LOWEST TO HIGHEST VOC CONTENT OF FORMULATIONS**

**Details Related to Data Sources and Methodological Approach**

As mentioned above, the blanket wash cost comparison considered three cost elements when comparing the performance of baseline and substitute blanket cleaners: labor costs (time x wage rate); blanket wash use (quantity x unit price), adjusting for dilution; and material and equipment costs # wipes x cost per wipe). Each element is described in more detail below. Also, Figure G-2 presents a graphical display of the relative contribution of labor, product use, and material use to the overall cost differences (compared to the baseline) for each of the substitute products. For example, performance results for product 1, tested at facility 6 indicate that overall costs per wash were $0.41 greater for Blanket Wash 6 compared to the baseline. The 40.41 difference is divided up as follows: costs associated with labor were $0.19 higher than the baseline, costs associated with product use (i.e., price x quantity) were $0.11 greater than the baseline, and costs associated with material and equipment use were $0.11 greater than the baseline.

**FIGURE G-2: COST DIFFERENCE BETWEEN SUBSTITUTE AND BASELINE BLANKET WASHES**

Labor Costs

The hourly wage and overhead rate for press operators was calculated from the *NAPL 1993 Cost Study*. The NAPL study presents a number of facility-specific characteristics, including: annual wages and overhead costs by press type and brand, number of shifts per day, length of work week, and vacations and holidays allowed. Because of the many variables impacting hourly wages and overhead rates, several assumptions were made to facilitate comparisons along the various alternatives.

*Assumptions*

- Based on a review of press sizes used in the performance demonstrations as well as discussions with performance demonstration observers, wage rates and overhead expenses for a 26-inch, 2-unit press were used in this analysis.

- The *NAPL 1993 Cost Study* presents three possible employment scenarios (referred to as areas A, B, and C), each with differing wages and overhead costs. The "areas" are defined as follows: (1) area A: 35 hours/week, 4 weeks paid vacation, and 11 paid holidays; (2) area B: 37.5 hours/week, 3 weeks paid vacation, and 10 paid holidays; and (3) area C: 40 hours/week, 2 weeks paid vacation, and 8 paid holidays. It was assumed that press operations at performance demonstrations shops operate under a 40 hour work week and are offered 2 weeks paid vacation and 8 paid holidays per year.

- Annual wages and overhead rates vary according to the number of (eight hour) shifts the press facility operates per day. As the number of shifts increase, the wage rate for all shifts increases and the overhead rate decreases. To estimate average wage and overhead rates for this analysis, hourly wage estimates and overhead rates were weighted according to the proportion of facilities participating in performance demonstrations operating one, two or three shifts per day.

- The NAPL cost study provides overhead expenses for seven brands of presses within the 26-inch, 2-unit press category. Overhead rates were calculated by averaging across the seven brands. Annual wages do not vary across the seven brands of presses.

*Hourly wage rate for a press operator*

As mentioned above, annual wage rates, presented in the NAPL cost study, do not vary across press type; however, wages do vary according to the number of shifts operated per day. In this analysis, a weighted average of $15.52/hour was calculated given that nine of the facilities that participated in the performance demonstration operate one shift per day, four facilities operate two shifts per day, and four facilities operate three shifts per day. Calculations of the average hourly wage are presented in Table G-3 below.

| TABLE G-3: CALCULATION OF AVERAGE HOURLY RATE | | | | |
|---|---|---|---|---|
| **# Shifts (8 hrs.)** | **Annual Wage** | **Hourly Wage** | **Weight (Facilities × shifts)** | **Wage × Weight** |
| 1 | $31,200 | $15.00 | 9 | $135 |
| 2 | $64,740 | $15.56 | 8 | $124 |
| 3 | $99,060 | $15.88 | 12 | $191 |
| **Totals:** | | | 29 | $450 |
| | | | | |
| **Total wage × weight:** | | | | $450.04 |
| **Total/29:** | | | | **$15.52** |

Source: *NAPL 1993 Cost Study.*

*Fringe rate*

To account for costs associated with fringe benefits such as holiday and vacation time, a fringe rate was calculated. The NAPL Cost Study indicates that press operators working a 40 hour week receive eight paid holidays and two weeks vacation per year. To calculate the fringe rate, non-productive hours were subtracted from total hours of operation per year (i.e., 2,080 hours minus 144 hours = 1936 hours). The ratio of total hours to productive hours is equal to the fringe rate applied to each hour worked (2080/1936 = 1.074).

*Overhead rate*

Overhead rates for this analysis are calculated according to the following formula:[3]

$$\frac{\text{depreciation + rent \& heat + fire \& sprinkler insurance + pension fund + welfare benefits + payroll taxes + workmen's comp. + light \& power + direct supplies + repairs to equipment + general factory + administrative \& selling overhead}}{\text{direct labor + supervisory and misc. labor}}$$

The NAPL cost study provides overhead expenses for seven brands of presses within the 26-inch, 2-unit press category. For the purposes of this analysis, overhead rates were averaged across the seven brands. As with the hourly wage calculations, a weighted average was calculated, accounting for the variability in the number of shifts a facility may operate per day. The overhead rate was estimated to be 1.99.

*Total Labor Cost*

The total labor cost associated with the use of an individual blanket wash was calculated by multiplying the average cleaning time by the press operator's hourly wage, overhead rate, and fringe rate. For example, the total labor cost for Blanket Wash 1, tested by facility 3, was

[3] Overhead cost elements were taken directly from the NAPL 1993 Cost Study.

calculated by multiplying the average time spent cleaning (37.5 seconds) by the wage per second ($15.52/60min/60sec[4]), overhead rate (1.99), and fringe rate (1.074) for a total cost of $0.35 per wash.

Blanket Wash Use

Costs attributable to blanket wash use were calculated by multiplying the average quantity of blanket cleaner used per wash cycle by the price of the appropriate wash. In cases where participants diluted blanket wash with water, the unit price was multiplied by the ratio of cleaner used and not the total quantity of the mixture. For example, if the dilution ratio was 1:1, the unit price of the blanket wash was multiplied by 0.5 to account for dilution and then multiplied by the volume used. As mentioned above, blanket wash prices were provided by manufacturers participating in the performance demonstrations. During the performance demonstrations it was observed that most printing facilities purchased blanket cleaner in 55-gallon quantities. This was assumed to be true of all printing facilities participating in the performance demonstration.

Material and Equipment Costs

Because the performance demonstrations were limited to manual blanket washing, the only materials or equipment affecting the cost of blanket washing were the wipes used by the press operator to remove ink and paper products. The cost of press wipes were calculated by multiplying the average number of wipes used per wash by the lease price of a cloth printer's wipe. A representative of Standard Uniform Services, one of the largest industrial laundries in Massachusetts, estimated a lease price of $0.11 per wipe.

Waste Disposal

Because blanket washing wastes may be classified as hazardous wastes by regulations implementing RCRA and therefore require more careful and costly handling and disposal, printers may reduce waste disposal costs if wastes associated with alternative blanket washes do not contain any RCRA listed wastes, eliminating the need to be handled as hazardous waste.[5] Disposal costs were not considered in this cost comparison, however, because all but one of the printers participating in the performance demonstrations use cloth wipes that are leased from an industrial laundry. Industrial laundries currently do not distinguish between hazardous and nonhazardous blanket washes when laundering wipes; it was therefore assumed that there would be no savings in waste handling or processing costs associated with switching to an alternative blanket wash product. In addition, the impact of alternative cleaners on the costs of handling and processing used wipes is unclear. For example, according to the Uniform and Textile Service Association, wipes impregnated with vegetable-oil based cleaners have a higher potential for

[4] The wage rate of $15.52 per hour translates to $0.0043 per second.

[5] Costs of managing hazardous wastes include placing the waste in a closed and properly labeled container, manifesting shipments and using special shipping arrangements, and shipping to a permitted hazardous waste treatment or disposal facility.

spontaneous combustion when piled together in a laundry bag. Vegetable-oil based cleaners break down, creating exothermic heat and the potential for spontaneous combustion. In addition, the vegetable oil-based cleaners may make wastewater treatment and permit compliance more difficult for the industrial laundry (Dunlap, 1995).

While there is a potential for reduction in waste treatment and disposal costs attributed to the use of alternative blanket cleaners, the current state of federal regulations is in flux. Also, there are many different state and local regulations which might dictate different treatment for hazardous blanket wash wastes. Specifically, future changes to RCRA and the Clean Water Act (CWA) could potentially create a cost advantage for printers using alternative blanket cleaners. Currently, under RCRA, the mixture rule classifies a non-hazardous waste as hazardous when combined with a listed waste (F, P, K, and U listed wastes). The mixture rule was struck down by a 1991 District of Columbia Circuit Court ruling, but was temporarily reenacted while EPA conducts a review of the rule. EPA has not provided definitive guidance on the treatment of solvent contaminated shop towels, leaving it to each state to provide guidance on the identification and management of press wipes.[6] Many states have responded by recognizing a conditional exemption from the mixture rule for contaminated press wipes. EPA's Office of Solid Waste is currently considering changes to the definition of hazardous and solid wastes that could potentially exempt press wipes from hazardous waste classification. Also, EPA is currently developing categorical standards for the industrial laundry industry that could potentially impact the cost of treating press wipes.

[6] The EPA is planning to develop guidance to the States for the use, reuse, transportation, and disposal of shop towels.

**APPENDIX G**

| TABLE G-2: SUMMARY OF COST ANALYSIS FOR BLANKET WASH PERFORMANCE DEMONSTRATION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Formula Number** | **Test Facility** | **Total cost/wash** | | **Total cost/press** | | **Total cost/press/shift/year** | | **Percentage Difference[a]** |
| | | **Baseline** | **Alternative** | **Baseline** | **Alternative** | **Baseline** | **Alternative** | |
| 1 | Facility 3 | 0.55 | 0.69 | 2.20 | 2.76 | 5,500 | 6,900 | +25 |
| | Facility 6 | 0.46 | 0.87 | 1.84 | 3.48 | 4,600 | 8,700 | +89 |
| 6 | Facility 11 | 0.70 | 0.82 | 2.80 | 3.28 | 7,000 | 8,200 | +17 |
| | Facility 15 | 0.50 | 0.77 | 2.00 | 3.08 | 5,000 | 7,700 | +54 |
| 9 | Facility 10 | 0.91 | 2.08 | 3.64 | 8.32 | 9,100 | 20,800 | +129 |
| | Facility 15 | 0.50 | 0.92 | 2.00 | 3.68 | 5,000 | 9,200 | +84 |
| 10 | Facility 3 | 0.55 | 0.57 | 2.20 | 2.28 | 5,500 | 5,700 | +4 |
| | Facility 4 | 0.85 | 2.20 | 3.40 | 8.80 | 8,500 | 22,000 | +159 |
| 11 | Facility 1 | 0.59 | 1.29 | 2.36 | 5.16 | 5,900 | 12,900 | +119 |
| | Facility 2 | 0.53 | 0.68 | 2.12 | 2.72 | 5,300 | 6,800 | +28 |
| 12 | Facility 12 | 0.81 | 0.99 | 3.24 | 3.96 | 8,100 | 9,900 | +22 |
| | Facility 13 | 0.80 | 0.83 | 3.20 | 3.32 | 8,000 | 8,300 | +4 |
| 14 | Facility 6 | 0.46 | 1.07 | 1.84 | 4.28 | 4,600 | 10,700 | +133 |
| | Facility 16 | 0.66 | 0.82 | 2.64 | 3.28 | 6,600 | 8,200 | +24 |
| 19 | Facility 18 | 0.62 | 1.66 | 2.48 | 6.64 | 6,200 | 16,600 | +168 |
| | Facility 19 | 0.53 | 0.89 | 2.12 | 3.56 | 5,300 | 8,900 | +68 |
| 20 | Facility 11 | 0.70 | 1.13 | 2.80 | 4.52 | 7,000 | 11,300 | +61 |
| | Facility 12 | 0.81 | 1.58 | 3.24 | 6.32 | 8,100 | 15,800 | +95 |

| TABLE G-2: SUMMARY OF COST ANALYSIS FOR BLANKET WASH PERFORMANCE DEMONSTRATION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21 | Facility 6 | 0.46 | 1.01 | 1.84 | 4.04 | 4,600 | 10,100 | +120 |
| | Facility 17 | 0.41 | 0.58 | 1.64 | 2.32 | 4,100 | 5,800 | +41 |
| 22 | Facility 12 | 0.81 | 0.82 | 3.24 | 3.28 | 8,100 | 8,200 | +1 |
| | Facility 13 | 0.80 | 1.51 | 3.20 | 6.04 | 8,000 | 15,100 | +89 |
| 24 | Facility 16 | 0.66 | 0.97 | 2.64 | 3.88 | 6,600 | 9,700 | +47 |
| | Facility 17 | 0.41 | 0.88 | 1.64 | 3.52 | 4,100 | 8,800 | +115 |
| 26 | Facility 5 | 0.55 | 0.73 | 2.20 | 2.92 | 5,500 | 7,300 | +33 |
| | Facility 15 | 0.50 | 0.47 | 2.00 | 1.88 | 5,000 | 4,700 | -6 |
| 29 | Facility 7 | 0.57 | 0.93 | 2.28 | 3.72 | 5,700 | 9,300 | +63 |
| | Facility 8 | 0.55 | 0.89 | 2.20 | 3.56 | 5,500 | 8,900 | +62 |
| 30 | Facility 18 | 0.62 | 1.01 | 2.48 | 4.04 | 6,200 | 10,100 | +63 |
| | Facility 19 | 0.53 | 0.62 | 2.12 | 2.48 | 5,300 | 6,200 | +17 |
| 31 | Facility 7 | 0.57 | 1.59 | 2.28 | 6.36 | 5,700 | 15,900 | +179 |
| | Facility 8 | 0.55 | 0.59 | 2.20 | 2.36 | 5,500 | 5,900 | +7 |
| 32 | Facility 1 | 0.59 | 1.31 | 2.36 | 5.24 | 5,900 | 13,100 | +122 |
| | Facility 5 | 0.53 | 0.43 | 2.12 | 1.72 | 5,300 | 4,300 | -19 |
| 34 | Facility 1 | 0.59 | 0.89 | 2.36 | 3.56 | 5,900 | 8,900 | +51 |
| | Facility 19 | 0.53 | 0.95 | 2.12 | 3.80 | 5,300 | 9,500 | +79 |
| 37 | Facility 3 | 0.55 | 0.48 | 2.20 | 1.92 | 5,500 | 4,800 | -13 |
| | Facility 4 | 0.85 | 0.79 | 3.40 | 3.16 | 8,500 | 7,900 | -7 |

| TABLE G-2: SUMMARY OF COST ANALYSIS FOR BLANKET WASH PERFORMANCE DEMONSTRATION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 38 | Facility 2 | 0.53 | 1.08 | 2.12 | 4.32 | 5,300 | 10,800 | +104 |
| | Facility 4 | 0.85 | 1.11 | 3.40 | 4.44 | 8,500 | 11,100 | +31 |
| 39 | Facility 5 | 0.55 | 0.69 | 2.20 | 2.76 | 5,500 | 6,900 | +25 |
| | Facility 8 | 0.55 | 0.80 | 2.20 | 3.20 | 5,500 | 8,000 | +45 |
| 40 | Facility 1 | 0.59 | 0.79 | 2.36 | 3.16 | 5,900 | 7,900 | +34 |
| | Facility 10 | 0.91 | 0.87 | 3.64 | 3.48 | 9,100 | 8,700 | -4 |

a) A positive sign denotes an increase and a negative sign denotes a decrease in the cost when using the alternative blanket cleaner instead of the base product.